

Exposure of cats to low doses of FeLV: seroconversion as the sole parameter of infection

Abstract

In felids, Feline Leukemia Virus (FeLV) infection results in a variety of outcomes that range from abortive to progressive infection. Recently, a novel outcome was postulated for low FeLV infectious doses. Naïve cats exposed to faeces of persistently infected cats seroconverted, indicating infection, but remained negative for provirus and p27 antigen in blood. FeLV provirus was found in some tissues but not in the bone marrow, infection of which is usually considered a necessary stage for disease progression. To investigate the impact of low FeLV doses on young cats and to test our hypothesis that low dose exposure may lead to an unknown pathogenesis of infection without involvement of the bone marrow, 21 cats were infected oronasally with variable viral doses. Blood p27, proviral and viral loads were followed until week 20 post-infection. Tissue proviral loads were determined as well. The immune response was monitored by FeLV whole virus and p45 ELISA, FOCMA assay and Western blot. One cat showed regressive infection. In 7 cats, FOCMA assay positivity was the only sign of infection. Provirus was only found in some organs of the regressively infected cat. Here, we show that FeLV low dose exposure can result in seroconversion during a presumed abortive infection. Therefore, commonly used detection methods do not cover the whole spectrum of FeLV pathogenesis, leading to a possible underestimation of the effective occurrence of infection in the cat population

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**Exposure of cats to low doses of FeLV: seroconversion as the sole
parameter of infection**

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In Dankbarkeit und Liebe meinen Eltern
gewidmet, die mir meine Ausbildung
ermöglicht und mich immer unterstützt
haben.

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INDEX OF ABBREVIATIONS

ELISA	enzyme linked immunosorbent assay
env	envelope gene
FeLV	f eline l eukemia V irus
FFU	f ocus f orming u nits
fGAPDH	f eline g lyceraldehydes-3- p hosphate d ehydrogenase
FIV	f eline immunodeficiency v irus
FOCMA	f eline o ncornavirus-associated c ell m embrane a ntigen
gp	g lycoprotein
PCR	p olymerase c hain r eaction
RT	r everse t ranscriptase
SPF	s pecific p athogen f ree

ABSTRACT

In felids, Feline Leukemia Virus (FeLV) infection results in a variety of outcomes that range from abortive to progressive infection. Recently, a novel outcome was postulated for low FeLV infectious doses. Naïve cats exposed to faeces of persistently infected cats seroconverted, indicating infection, but remained negative for provirus and p27 antigen in blood. FeLV provirus was found in some tissues but not in the bone marrow, infection of which is usually considered a necessary stage for disease progression. To investigate the impact of low FeLV doses on young cats and to test our hypothesis that low dose exposure may lead to an unknown pathogenesis of infection without involvement of the bone marrow, 21 cats were infected oronasally with variable viral doses. Blood p27, proviral and viral loads were followed until week 20 post-infection. Tissue proviral loads were determined as well. The immune response was monitored by FeLV whole virus and p45 ELISA, FOCMA assay and Western blot. One cat showed regressive infection. In 7 cats, FOCMA assay positivity was the only sign of infection. Provirus was only found in some organs of the regressively infected cat. Here, we show that FeLV low dose exposure can result in seroconversion during a presumed abortive infection. Therefore, commonly used detection methods do not cover the whole spectrum of FeLV pathogenesis, leading to a possible underestimation of the effective occurrence of infection in the cat population.

1 INTRODUCTION

Feline Leukemia virus is a retrovirus of great veterinary importance. It was discovered more than 40 years ago [1]. FeLV infects domestic cats and some related small felids worldwide [2, 3]. An infection with FeLV may cause blood disorders, a state of immunodeficiency and fatal neoplasia. Common symptoms are fever, anaemia, anorexia, weight loss, vomitus and diarrhoea.

The prevalence of FeLV infection has been decreasing in the past few years. In Switzerland, FeLV prevalence was found to be 3% in healthy and of up to 13% in ill cats [4]. Decreasing prevalence is the consequence of identification and segregation of infected cats, and of extensive vaccination programs. However, cases of recurrence keep occurring and emphasise the importance of an accurate diagnosis.

FeLV is mainly transmitted directly from cat to cat. Transmission occurs through contact with saliva via licking, mutual grooming and sharing of food or water dishes or through bites [5, 6]. Infectious FeLV can also be transmitted via faeces and milk [7, 8]. FeLV RNA was also detected in urine, but, its infection potential has not been demonstrated so far [9]. Pathogenesis is well understood if infectious pressure is high. Infection starts in the oropharynx where the virus first replicates in tonsils and local lymph nodes [10], from which the virus spreads to the bone marrow, thymus, spleen and intestine through infected lymphocytes. Bone marrow infection is an important hallmark of FeLV pathogenesis as the virus replicates extensively in the bone marrow and infects blood precursor cells. Once the bone marrow is infected, viremia develops and many organs and tissues are affected, including salivary gland, tonsils, pharyngeal, urinary bladder, gastric, intestinal, colonic, pancreatic and endometrial epithelia, lymph nodes throughout the body, bone marrow, and spleen [10, 11].

FeLV infection presents a variety of outcomes [2, 10, 12-18], which are influenced by both host and virus factors. Known host resistance factors include age and immune system status. Known virologic factors are virus strain, subtype and viral infection dose [2].

The outcome of infection is still somewhat a controversial issue. In the past, infection outcome was classified as viremic, non-viremic, and transient viremic based on results of virus isolation, immunofluorescence assays and/or antigen detection

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[16]. Viremic cats are characterized by continuous expression of p27 viral antigen. FeLV infection is not contained due to a lack of FeLV specific immunity [2, 19, 20]. Viremic cats continuously shed virus, thereby posing a risk of infection to susceptible cats, and usually succumb to FeLV-associated diseases (anaemia, immunosuppression, neoplasia). In transiently viremic cats, viremia is overcome after a few weeks post infection. However, transiently viremic cats remain provirus positive. In addition, some non-viremic cats were shown to have localized infection characterized by virus replication in certain tissues, such as mammary, salivary and urinary epithelium [7, 8, 21]. This additional form of FeLV infection was termed atypical or sequestered infection. New sensitive molecular assays have been described recently for the use in detection and quantification of FeLV provirus DNA and viral RNA [22-24], resulting in a more sensitive measure for FeLV exposure. The spectrum of host response categories was refined accordingly. Especially in p27 negative cats, the outcome should be re-evaluated based on the presence or absence of FeLV proviral DNA in blood or bone marrow. The spectrum of host response categories was thus reclassified into: abortive (no virus detected after exposure), regressive (p27-negative, provirus positive after or without transient antigenemia) and progressive (persistently p27 positive, virus isolation, provirus positive, FeLV RNA positive) [18]. Whether cats that show no signs of infection (abortive) are truly immune or just resistant, is still open to debate.

In this context, a very interesting finding was that FeLV infection can be transmitted exclusively by contact with faeces [7] with no apparent viremia and infection involving the bone marrow, and constant negativity for proviral DNA in blood – which would be classified as abortive infection. However, in the study of Gomes et al. FeLV provirus could be detected in several organs and the cats showed seroconversion, indicating that infection indeed had occurred. It was concluded that under low infectious pressure a different pathogenesis may take place in which bone marrow is not involved.

Since FeLV transmission at very low infection levels appears to be the most natural way of infection, many cats may show this yet uncharacterized outcome. Cats that test negative for FeLV by conventional diagnostic methods could still have been infected and constitute a relevant portion of the cat population affected by the virus. The prevalence of FeLV infection may therefore have been underestimated, a factor that may have important consequences for FeLV control management – notably in

Iberian lynxes, which seem to be particularly susceptible for FeLV infection [25] and for which a correct estimation of FeLV spreading potential is of great importance.

It was thus the aim of this study to further characterize the course of infection after exposure to low infectious pressure and to test the hypothesis that low FeLV doses applied to young cats may lead to seroconversion also when the infection does not progress through bone marrow. The virus may not be completely eliminated and a limited viral replication in tissues may lead to a development of a weak immune response. We exposed each of three groups of 7 cats to different, low doses of FeLV. Blood p27 antigen, proviral DNA and viral RNA were measured in blood at regular intervals until week 20 post infection and in popliteal and mesenteric lymph nodes, bone marrow, spleen, kidney, urinary bladder, lungs, thymus, myocardium, parotid gland, and pancreas after euthanasia. Immune response against FeLV was assessed by the detection of antibodies by ELISA to FeLV whole virus and to FeLV p45 (the recombinant env-gene product), by immunofluorescence assay to feline oncornavirus-associated cell membrane antigen (FOCMA), and by Western blot analysis to the separated FeLV components.

2 MATERIAL AND METHODS

2.1 Animals

Twenty-six, 9 weeks-old Specific Pathogen-Free (SPF) male kittens were obtained from Liberty Research, Inc. (Waverly, NY, USA). Animals were kept under barrier conditions and optimal ethological and hygienic conditions in one group of 5 cats (uninfected control group) and three groups of 7 cats each (group 1K, 10K, and 100K, based on viral infectious dose). Prior to the beginning of the experiment the cats were tested by PCR, RT-PCR and serology and shown to be negative for FeLV, FIV, Herpes-, Corona-, Calici-, Parvovirus and feline hemotropic mycoplasmas.

2.2 FeLV-A virus challenge

At the age of 16 weeks, each kitten of groups 1K, 10K, and 100K were infected once oronasally with FeLV-A/Glasgow-1 [26] by introducing 0.2ml of virus suspension into each nostril and 0.6ml into the mouth. The virus suspension for group 1K contained a total of 1'000 focus-forming units (FFU), the one for group 10K 10'000 FFUs and group 100K 100'0000 FFUs. The viral stock origin and infectivity was the same as described in earlier works [27, 28].

2.3 Sample collection and processing

Blood samples were collected under sedation (0.1mg/kg midazolam (Dormicum®, Roche Pharma AG, Reinach, Switzerland) and 10mg/kg ketamine (Narketan®, Vétoquinol AG, Belp, Switzerland) prior to challenge at week -7, -5, -3, and then weekly, starting from week 0 until week 6 post-infection (p.i.), later in biweekly intervals until week 20 p.i. Blood samples were obtained by jugular venipuncture using 5ml syringes and blood was immediately transferred into EDTA-tubes.

400µl of EDTA blood was submitted for haematology analysis, 200µl of EDTA anticoagulated whole blood were aliquoted for DNA extraction.

Plasma was obtained by centrifuging approximately 2ml of EDTA blood at 1700g for 10 minutes. Blood and plasma samples were immediately frozen at -80 °C until they were processed.

2.4 Detection of proviral DNA and plasma viral RNA

For determination of FeLV proviral loads, total nucleic acids were extracted from a blood volume containing 10^6 white blood cells using the MagNa Pure LC Total Nucleic Acid Isolation Kit (Roche diagnostics AG, Rotkreuz, Switzerland). The extracted total nucleic acids were analyzed by real-time TaqMan PCR as described [24] on a ABI 7500 sequence detection system (Applied Biosystems, Foster City, CA, USA).

For each run, a glyceraldehyde-3-phosphate dehydrogenase (GAPDH) pseudogene of which one copy is present in the genomic DNA of feline cells [29] was also quantified. FeLV proviral DNA amounts were normalized to feline GAPDH by dividing FeLV copy numbers by fGAPDH copy numbers to calculate FeLV copies per cell.

Viral RNA in plasma samples was extracted from 200µl of plasma (either from 5-sample pools or from single samples) using the MagNa Pure LC Total Nucleic Isolation Kit and quantified by real-time TaqMan reverse transcriptase (RT)-PCR as described [24].

2. Detection of FeLV virus protein p27 by ELISA

The presence of plasma FeLV p27 antigen was determined using a sandwich ELISA as previously described [30]. Results are represented as percentages of a defined positive control (culture supernatant of FL-74 feline lymphoblastoid cell line permanently expressing FeLV), which was considered 100%. Samples reaching > 5% of the positive control signal were considered positive.

2.6 Antibody assays

The plasma samples were also analysed for the presence of antibodies to FeLV whole virus, to FeLV p45 (the non-glycosylated form of gp70 surface unit of the envelope glycoprotein), and to FOCMA.

2.6.1 FeLV p45 and whole virus ELISAs

Anti-FeLV p45 and anti-FeLV whole virus antibodies were measured by ELISA as described [15, 31], using 100ng of p45/well and 100ng of gradient purified FL-74 FeLV, respectively. Plasma was used at a dilution of 1:200.

2.6.2 FL-74 cell membrane immunofluorescence assay

Antibody to FOCMA was measured at week 0 and week 20 p.i., by indirect cell membrane immunofluorescence as described [32]. FL-74 cell culture medium was tested for the absence of FCV, FHV, FPV, FCoV, FIV, hemotropic mycoplasma and presence of FeLV by RT-PCR/PCR as described [24, 33-38]. The culture was consistently free of the unwanted contaminants. The cat sera were titrated at 4-fold dilutions from 1:4 to 1:256. The antibody titre was taken as the reciprocal of the highest dilution of serum producing bright ring fluorescence.

2.6.3 Western blot analysis

In addition, samples from week -3 and week 20 p.i. were examined for the presence of antibodies to FeLV gp70, p27 and p15(E) [30, 39] by Western blot analysis as described [40].

2.7 Detection of FeLV provirus and virus isolation from tissues and bone marrow

Cats of group 10K and group 100K were euthanized in week 20, and tissue samples from popliteal and mesenteric lymph nodes, bone marrow, spleen, kidney, urinary bladder, lungs, thymus, myocardium, parotid gland, and pancreas were collected within 30 min post-mortem. Samples were immediately snap-frozen in liquid nitrogen. 10mg of tissue were used for the extraction of DNA using MagNA Pure LC DNA Isolation Kit II [Tissue] (Roche Diagnostics, Mannheim, Germany). FeLV provirus was quantified by real-time PCR as described above [24, 41]. To guarantee a comparable sensitivity, samples yielding less than 15'000 fGAPDH copies per reaction were re-extracted until a suitable concentration was reached.

In addition, we collected samples under sterile conditions from mesenteric lymph node, urinary bladder, lungs, thymus, and myocardium for virus isolation. Tissue samples were co-cultured with FEA cells and supernatants of the co-cultures collected at days 4, 8, 12, 16, 20, 24, and 28 post-inoculation were tested for p27 antigen by ELISA as described [42].

Bone marrow samples were cultured in medium and supernatants collected at days 18 and 21 were used for total nucleic acid isolation (MagNA Pure LC Total

Nucleic Acid Isolation Kit, Roche Diagnostics) and samples were tested for the presence of FeLV RNA. Additionally, supernatants were tested by p27 ELISA [30].

2.8 Statistical analysis

Statistical analyses were carried out using R software version 2.9.0. (The R Foundation for Statistical Computing, Vienna, Austria). Longitudinal effects (time) on antibody titres of the different groups were compared to each other by multivariate analysis of variance (MANOVA). A p-value <0.05 was considered to be statistically significant.

3 RESULTS

3.1 FeLV DNA and RNA detection in blood

With one exception, cats did not become provirus positive at any time point tested. The one cat (JCR2) that was found to be positive belonged to the group challenged with the highest of the three doses of FeLV (100'000 FFUs). Proviral DNA was detected from week 2 p.i. on with a peak at week 3 (3.33 copies/cell) (Figure 1).

Similarly, viral RNA was consistently detected only in samples of the provirus-positive cat (JCR2) until week 12 and additionally at week 18 once more. The highest viral RNA load measured was at week 2 p.i. (Ct-value of 22.95, Figure 1). We were not able to detect viral RNA in pooled plasma samples (5 samples each pool) of any of the provirus-negative cats at week 0, 10, and 20 p.i.. In addition, samples from week 2, 3, and 4 were tested individually, as the viral RNA peak usually occurs in this time period; the results were negative, too.

3.2 Detection of p27 in plasma

P27 antigen was detected in plasma of one (JCR2) of the 26 cats tested. This cat became transiently positive at week 3 p.i. and week 4 p.i. (Figure 1). We were not able to detect p27 at any time point in all other cats.

3.3 Antibody assays

3.3.1 FeLV p45 and whole virus ELISAs

By measuring antibodies against FeLV p45 and whole virus by ELISA, seroconversion was observed in one cat. In the p45 ELISA, this cat (JCR2) had a positive response throughout weeks 8 to 20 with a peak of 26% of the positive control at week 14, and throughout weeks 4 to 20 with a peak of 54% of the positive control at week 20 in the FeLV whole virus ELISA (data not shown). Analysis of the remaining animals showed no statistically relevant difference between the groups in p45 as well as whole virus ELISA (P_{MANOVA} 0.53 and 0.47, respectively. Figure 2 and 3).

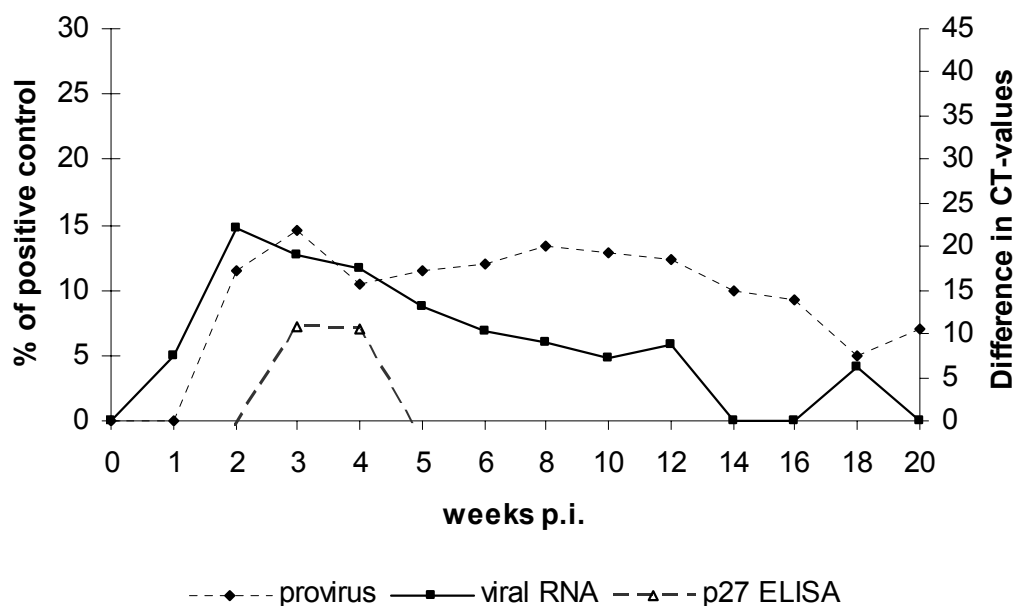


Figure 1. Proviral DNA, viral RNA, and plasma p27 loads from the persistent PCR-positive cat JCR2 measured at regular intervals until week 20 p.i.

Provirus loads are expressed as cycle threshold (Ct) value 45 (considered to be negative) minus Ct values measured. p27 antigen ELISA values are represented as percentage in comparison to a positive control (FL-74 lymphoblastoid cell culture supernatant), which was considered to be 100%. The cat JCR2 found to be consistently provirus positive, showed a regressive infection with transient antigenemia.

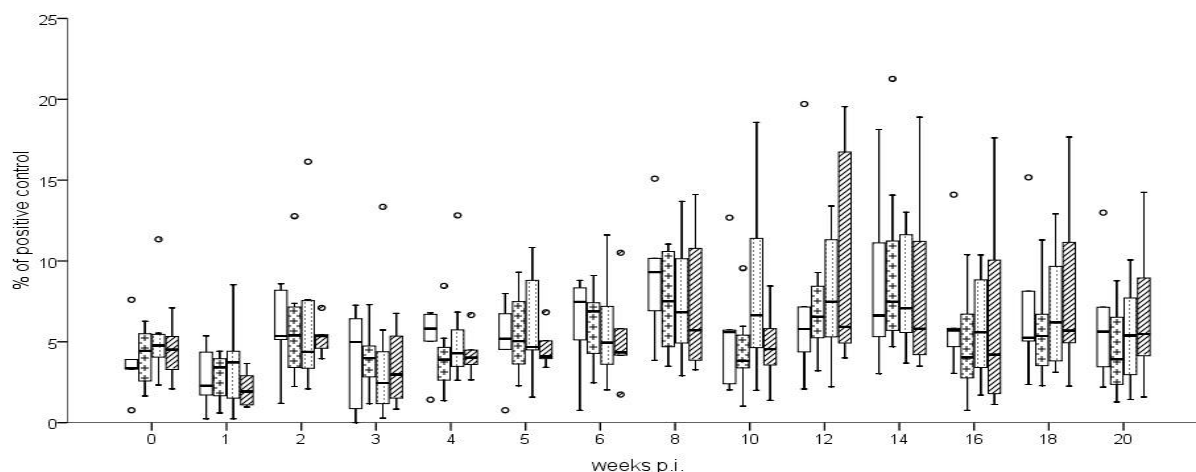


Figure 2. Box-plot results obtained measuring antibodies directed to FeLV p45 over the whole observation period as percentage of the positive control. The PCR-positive cat of group 100K was excluded. No statistically relevant difference between the groups was observed. Open boxes: negative controls, crossed boxes: 1K group, dotted boxes: 10K group, hatched boxes: 100K group. Outliers are depicted by a dot.

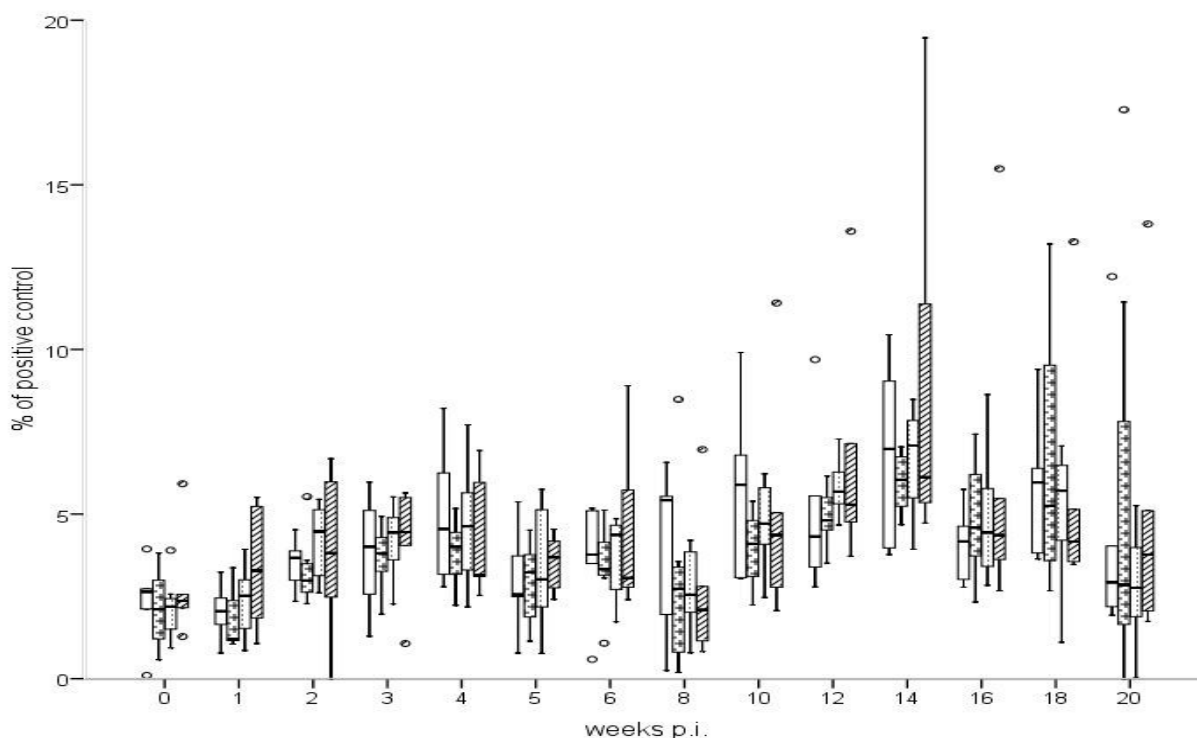


Figure 3. Antibodies directed to FeLV whole virus. Results are expressed as percentage of a positive control. The PCR-positive cat of group 100K was excluded. No statistically relevant difference between the groups was observed. Open boxes: negative controls, crossed boxes: 1K group, dotted boxes: 10K group, hatched boxes: 100K group. Outliers are depicted by a dot.

3.3.2 FL-74 cell membrane immunofluorescence assay

Prior to challenge, all samples were negative for the presence of antibodies directed against FOCMA. At week 20 p.i., antibodies to FOCMA were detected in 4 cats (KCT1, JCU3, JCO2, JCP1, 57%) of group 10K and 4 (KDA1, JCR2, KCQ1, JCS1, 57%) cats of group 100K. Of these 8 cats, the PCR-positive cat (JCR2) reached the highest titre (64), the other 7 cats developed antibody titres which ranged from 1 to 16. No negative control group and group 1K animal had a detectable titre (Table 1).

TABLE 1. Titres of antibodies detected by indirect FL-74 FOCMA immunofluorescence test pre- and post exposure to low FeLV doses.

titre	neg. control		group 1K		group 10K		group 100K	
	week 0	week 20	week 0	week 20	week 0	week 20	week 0	week 20
neg	7 ^a	7	7	7	7	3	7	3
4	0	0	0	0	0	2	0	3
16	0	0	0	0	0	2	0	0
64	0	0	0	0	0	0	0	1

^a Numbers represent the total number of cats with a certain titer

3.3.3 Western blot analysis

In Western blot analysis, sera from two cats of group 10K (JCU3, JCS2) showed a weak reactivity to the upper band of the p15(E) protein at a serum dilution of 1:40 as well as at 1:100. One cat of group 100K (KDA1) showed a weak reactivity to the p58 protein. However, cat JCU3 showed some reactivity to the upper band of p15(E) and cat KDA1 to the band of p58, respectively, already at week 0 p.i. (Figure 4). In the PCR-positive cat (JCR2) the presence of antibodies against FeLV was confirmed at a dilution of 1:100. All other cats had completely negative Western blot pattern (Figure 4).

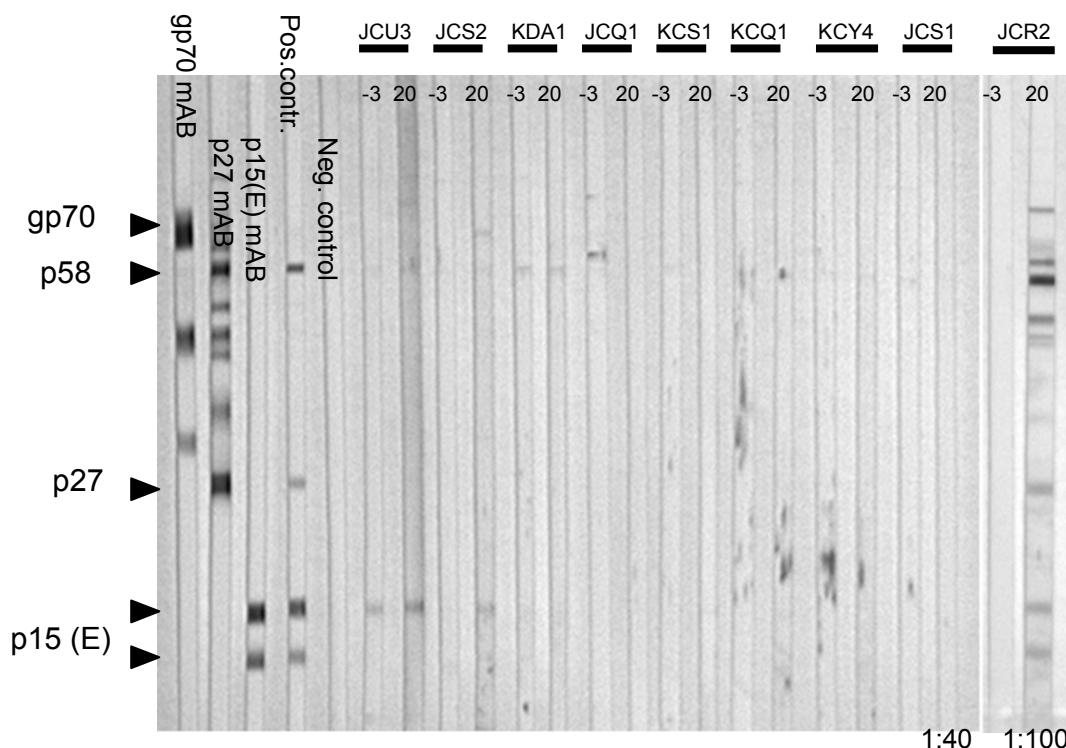


Figure 4. Western blot analysis using plasma samples from week -3 (prior to challenge) and week 20 p.i. (cats group 100K and two of group 10K)

The first 3 strips to the left were incubated with monoclonal antibodies against gp70, p27 and p15(E), respectively, to characterize the respective viral proteins.

Serum obtained from a pool of immune cats used as a positive control. Cat *JCU3* and cat *JCS2* (group 10K) show a weak reaction with the upper band of the p15(E) protein. Cat *KDA1* (group 100K) shows a weak reactivity to the band of the p58 protein. *JCR2* shows antibodies to all FeLV proteins. In all other cats, responses to any FeLV proteins could not be detected. (►) bands with expected length. All samples were tested under the same assay conditions.

3.4 Detection of FeLV DNA sequences and virus isolation from tissues

At week 20 post-challenge, cats of groups 10K and 100K were euthanized and different tissue samples were collected and analysed for the presence of FeLV DNA sequences. Popliteal and mesenteric lymph nodes, bone marrow, spleen, kidney, urinary bladder, lungs, thymus, myocardium, parotid gland, and pancreas were tested.

FeLV DNA sequences were found in organs of the cat (*JCR2*) positive for FeLV provirus in blood. The copy numbers were in average very low and ranged from 5.6 to 704.25 copies/reaction (3.4×10^{-5} to 0.0024 copies/cell, data not shown).

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The popliteal lymph node showed the highest FeLV proviral load (0.0024 copies/cell). No FeLV DNA sequences were detected in tissue samples of all other cats.

Virus isolation from urinary bladder, myocardium, lungs, mesenteric lymph node, thymus, and bone marrow was negative for all cats.

4 DISCUSSION

The aim of this study was to investigate to what degree cats can become infected by low-dose oral FeLV infection without detectable involvement of the bone marrow.

Even though FeLV prevalence has reportedly decreased during the past years, it is still among the most important infectious diseases of cats. Hence, a deep knowledge of all aspects of FeLV pathogenesis and biology is essential. Recently, a novel course of infection was postulated that deviates from the classical course involving a phase in which bone marrow is infected. In this alternative course, cats exposed to low loads of virus via faecal route seroconverted without involvement of bone marrow and without showing any other sign of infection [7]. Under field conditions, exposure to small virus loads is expected to be frequent due to superficial direct contact with viremic cats shedding FeLV or indirectly through contact with excretions produced by viremic cats. Thus, many cats may show this newly recognized outcome. Since experimental infection had to mimic the natural mode of transmission through faeces or saliva, in the present study we challenged the cats oronasally with viral loads that, based on published results [43] and on our experience, would induce abortive or regressive infection. Indeed, only one cat belonging to the group with the highest challenge dose showed regressive infection. For all other cats, abortive infection would have been assigned based on commonly used methods [18].

In this study, we demonstrated that a single oronasal exposure to FeLV as low as 10'000 FFU is sufficient to elicit an antibody response and to lead to seroconversion in at least 18% (lower 95% confidence interval of the distribution) of the cats, demonstrating that the postulated alternative course of infection may occur in a considerable portion of the animals. We propose to designate this outcome of infection as abortive infection with seroconversion. No hallmark of infection was observed in the cats that received the smallest of the three doses (1'000 FFU), for which individual local innate immunity might have been enough to contain viral replication and to lead to abortive infection without a detectable adaptive immune response. However, under field conditions, multiple exposures in the range of 1'000 FFUs or lower may occur giving rise to seroconversion or even provirus positivity.

Considering that our assay for proviral DNA is able to detect one copy per reaction, we believe that the consistent PCR-negativity in blood of the cats that seroconverted is a strong indicator for the absence of bone marrow infection, a confirmation that an alternative course of infection may indeed exist, where the bone marrow is not involved. FeLV provirus may still be integrated into the genome of the cells of some tissues but, in most cases, at levels beyond detection. In our study, we were not able to detect any FeLV DNA sequences in the organs tested. However, the presence of FeLV provirus in tissues other than the ones we analysed can not be excluded and should be investigated further. In localized infection where FeLV replication is confined to certain tissues, presence of plasma viral RNA loads is regarded a sensitive parameter for infection. RNA loads reflect ongoing viral replication somewhere in the cat's body even in sequestered places. However, detection of RNA is generally less frequent than that of proviral DNA [24].

Seroconversion was observed by use of the FL-74 cell membrane immunofluorescence test. This assay originally had been designated FOCMA test and was thought to detect antibodies at a non-virion tumour-associated antigen [32]. Later, it became clear that the FOCMA phenomenon can be explained not by a tumour specific antigen but by viral proteins including FeLV p15(E), gag-polyproteins and gp70 of FeLV subtype C present on the FL-74 cell membrane [44]. The FL-74 cell membrane immunofluorescence test seems to be the most sensitive method to detect seroconversion compared to ELISA and Western blotting. This may be due in part to the less stringent test conditions, which allow antibodies with lower affinity to bind to their epitopes, and in part to the fact that in the FOCMA assay the binding targets are presented in a native-like conformation, thus allowing a better binding of conformation-depending specific antibodies.

We did not test whether the oral low-dose infection did induce cytotoxic T-cells or virus-neutralizing antibodies, nor did we measure Th-1 cytokine expression that might have been induced by the experimental infection. We concentrated on the detection of antibodies as they can serve as markers of infection.

It is unclear to what degree the alternative pathway may be relevant to the spread of FeLV infection. We speculate that in most cases cats will overcome the infection for good. In very few cases - when the infected cats undergoes immunosuppression due e.g. to concomitant FIV infection - full-blown FeLV infection

with bone marrow involvement and viral shedding may develop. It will be important to determine to what extent this may occur.

5 CONCLUSION

The present extends the evidence for existence of an alternative FeLV infection course that leads to seroconversion without involvement of the bone marrow phase. The results may be important for the surveillance of the FeLV status of a cattery or a cat population. Most likely a cattery cannot be considered free of FeLV as long as cats with seroconversion are present. The potential for overt infection cannot be neglected.

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